Manufacturing routes for actively cooled structural components for ITER port plugs

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The upper ports at the ITER vacuum vessel (VV) are reserved for electron cyclotron heating & current drive (ECH&CD) systems and diagnostic systems. It is an important aspect in the conceptual design development to achieve a pronounced degree of communality, and thus to work out widely applicable manufacturing routes for the port plug structures. The first wall to the plasma is formed by the first wall panel (FWP) as the front part of the blanket shield module (BSM). The FWP is exposed to radiation loads up to 50 W/cm² and to volumetric heat loads of up to 3 W/cm³ which decay very fast further back. Thus very efficient active cooling structures are indispensable up to the first 150 cm behind the FWP. The BSM housing and the more distant main frame are formed by stainless steel (AISI 316 L(N)). Guided by this material choice, double wall structures are under development to respond to the special cooling request. In this concept, ribs between the inner and outer wall form meandering cooling channels, fed by water of 100°C at a pressure of 3 MPa. As both the inner and outer wall parts are in-vessel components, the manufacturing has to ensure a optimum performance component with respect to leak tightness, mechanical robustness and high geometrical precision.

Manufacturing routes are under development of which the most elaborate one is hot isostatic pressing (HIP). Along this route, two approaches can be exploited in principal namely joining machined parts by diffusion welding or direct forming by HIPping of metal powders. Their suitability as a reference manufacturing route is studied, which includes microstructural analysis the joining interfaces between ribs and walls. Alternative manufacturing approaches are compared in which the outer and inner wall structure are brazed and then welded to the connecting flange that interfaces the main structure.

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